TABLE OF CONTENTS

Chapter -1	**Introduction**	----------	2
	1.1 Markov Process	----------	3
	1.2 Hidden Markov Models (HMMs) – A General Overview	----------	3
	1.3 Need of Machine Learning	----------	5
	1.4 Machine Learning	----------	6
	1.5 Terminologies of Machine Learning	----------	8
	1.6 Classification of Machine Learning	----------	8
	1.7 Challenges and Limitations of Machine learning	----------	10
	1.8 Application of Machine learning	----------	10
	1.9 Motivation	----------	10
Chapter -2	**Literature Review**	----------	12
	2.1 Review	----------	12
	2.2 Rationale	----------	14
Chapter -3	**Objective of the Study**	----------	15
	3.1 Objective	----------	15
Chapter -4	**Proposed Methodology**	----------	16
	4.1 Proposed flow chart	----------	16
	4.2 Research Tools	----------	17
	References	----------	18

CHAPTER 1
INTRODUCTION

INTRODUCTION

Machine learning (ML) and Deep Learning (DL) is the subset of artificial intelligence (AI). The main objective of machine learning is to understand the hidden pattern of data and analyze that data for prediction which can be easily access for benefit of society. Algorithm are nothing but traditional set of explicitly programmed instructions used in traditional computing for problem solving. Machine learning train the amount of data inputs and test the data for statistical analysis. Because of this, machine learning builds the mathematical models from the sample data in order to make self learning decision process based on data inputs. In the previous decade, AI has given us self-driving autos, down to earth discourse acknowledgment, compelling web seek, and a boundlessly improved comprehension of the human genome. AI is so significant procedure today that most likely it is use deliberately and unexpectedly many times each day without knowing it. Numerous specialists additionally think it is the most ideal approach to gain ground. The essential strategy of AI is to manufacture calculations that can take input information and use for better prescient. Another area of machine learning applications is in the field of pattern recognition using DWT and HMM. Statistical signal modeling using HMM is one of the strategies used for image compression. Discrete Wavelet remodel (DWT) primarily based statistical signal fashions are impractical for maximum of the actual time processing because they usually constitute the wavelet coefficients as collectively Gaussian or unbiased to every different. An algorithm is increase that succinctly characterizes the interdependencies of wavelet coefficients and their Non -Gaussian behavior especially for photo compression. this is done by means of extracting the combine characteristic of HMM and DWT that offers us relatively better results. To estimate the parameter of DWT primarily based HMM, an green expectation maximization algorithm is evolved.

1.1 Markov Process:

A Markov technique is a random process wherein the future is independent of the past, given the existing. Therefore, Markov methods are the herbal stochastic analogs of the deterministic processes described by using differential and distinction equations. They shape one of the maximum important lessons of random processes. Markov techniques, named for Andrei Markov, are the various maximum important of all random processes. In an experience, they're the stochastic analogs of differential equations and recurrence relations that are of direction, some of the maximum crucial deterministic techniques.

1.2 Hidden Markov Models (HMMs) – A General Overview

A statistical tool used for modelling generative sequences characterized by a set of observable sequences. The HMM framework can be used to model stochastic processes where the non-observable state of the system is governed by a Markov process. The observable sequences of system have an underlying probabilistic dependence. HMMs can be applied in many fields where the goal is to recover a data sequence that is not immediately observable (but other data that depend on the sequence are).

	System state is fully Observable	System state is partially Observable
System is Autonomous	Markov Chain	HMM
System is Controlled	Markov Decision Process	Partially observable Markov Decision process

Markov chain:

The distribution of variable relies upon at the preceding kingdom [34].

Applications include:

- Computational finance
- Single-molecule kinetic analysis
- Cryptanalysis
- Speech recognition, including Siri
- Speech synthesis
- Part-of-speech tagging
- Document separation in scanning solutions
- Machine translation
- Partial discharge
- Gene prediction
- Handwriting recognition
- Alignment of bio-sequences
- Time series analysis

1.3 Need of Machine Learning

- ML is a system that can learn from sample data through self-improvement and without being explicitly program to produce the accurate precise outcomes.
- ML consolidates information with factual model to foresee a yield. This yield is then Utilized by corporate for better execution. AI is firmly partner with information Mining and Bayesian prescient demonstrating. The machine gets information as Information; utilize a calculation to detail answers.
- Average ML errands are to give a suggestion to better framework. For the individuals who have a Netflix account, all suggestions of motion pictures or arrangement depend on the client's chronicled information. Unsupervised Learning is utilized by Tech organizations to improve the client involvement with customizing suggestion.
- ML is likewise utilized for an assortment of uses like Face acknowledgment, Handwriting acknowledgment, biomedical picture examination, misrepresentation identification, prescient support, portfolio enhancement, automatism task.

- Machine Learning varies fundamentally from Traditional Programming. In conventional programming, a developer codes every one of the principles in discussion with an industry master for which programming is being created.
- Each standard depends on a legitimate cellar; the machine will execute a yield dependent on the intelligent explanation. At the point when the framework ends up mind boggling, more standards should be to beat this issue, in ML how the info and yield information are associated with one another and it composes a standard for code.

1.4 Machine Learning

- The ML theme was proposed by an American pioneer Arthur Samuel in 1959, in the field of PC gaming and man-made consciousness and expressed that "it enables PCs to learn without being unequivocally modified".
- It has the right to, as it is a standout amongst the most intriguing subfield of Computer Science. So what machines learning truly mean.
- Try to comprehend ML in layman terms. Think of you as are endeavouring to hurl a paper to a dustbin.
- After first endeavour, you understand that you have put a lot of power in it. After second endeavour, you understand you are nearer to target yet you have to build your toss point. What's going on here is essentially after each toss we are getting the hang of something and improving the final product. We are customized to gain from our experience.
- This infers that the errand in which ML is concerned offers an on a very basic level operational definition as opposed to characterizing the field in subjective terms.
- The field of information investigation, AI is utilized to devise complex models and calculations that loan themselves to forecast; in business use, this is known as prescient examination. These scientific models permit specialists, information researchers, designers, and investigators to "produce solid, repeatable choices and results" and reveal "concealed bits of knowledge" through gaining from authentic connections and patterns in the informational collection (input).

Traditional Programming:

Machine Learning:

Fig 1.1. Block diagram of Machine Learning and Traditional Programming

- Fig 1.1 shows Block diagram of Machine Learning and Traditional Programming. The difference between Machine learning and traditional Programming is in Machine Learning Data and output is given as input and Program/Model is an output as shown in Fig. 1.2. Whereas in Traditional Programming Data and Program (Task) is given an input and accordingly it gives output as shown in Fig. 1.3.

Fig 1.2. Block diagram of Traditional Programming

Fig 1.3. Block diagram of Machine Learning

1.5 Terminologies of Machine Learning

- **Model**

  A model is a specific representation learned from data by applying some machine learning algorithm. A model is also called hypothesis.

- **Feature**

  A feature is an individual measurable property of our data. A set of numeric features can be conveniently described by a feature vector. Feature vectors are fed as input to the model.

- **Target(Label)**

  A target variable or label is the value to be predicted by our model. For the fruit example discussed in the features section, the label with each set of input would be the name of the fruit like apple, orange, banana, etc.

- **Training**

  The idea is to give a set of inputs (features) and it's expected outputs (labels), so after training, we will have a model (hypothesis) that will then map new data to one of the categories trained on.

- **Prediction**

  Once our model is ready, it can be fed a set of inputs to which it will provide a predicted output (label). When the calculation gets the hang of reaching the correct inferences, it applies that information to new arrangements of information.

1.6 Classification of Machine Learning

1.6.1. Supervised Machine Learning Algorithms

Regulated Learning Algorithms include direct supervision of the activity. For this situation. In this case, both the input and desired output is provided. It is a spoon-fed version of machine learning. Input and output data are used for classification to provide learning for prediction.

1.6.2 Unsupervised Machine Learning Algorithms

Unsupervised learning is the one that doesn't involve direct manage of the developer. In Unsupervised studying statistics is neither categorised or labeled and design the algorithm for prediction .If the primary manner of supervised system learning is that you understand the effects and want to kind out the statistics and in case of unsupervised machine studying algorithms the desired outcomes are not recognized and yet to be described. any other large distinction between the two is that supervised getting to know uses categorised facts completely, while unsupervised getting to know feeds on unlabeled information.

1.6.3 Semi-supervised Machine Learning Algorithms

Semi-supervised learning algorithms lies in among supervised and unsupervised algorithms. Inside the undertaking, the semi-supervised version combines some

factors of both right into a aspect of its non-public going for walks.How semi-supervised algorithms works:

• Semi-supervised gadget gaining knowledge of set of rules makes use of a restrained set of categorised pattern records to shape the requirements of the operation (i.e., educate itself).

• The hindrance outcomes in a partially educated model that later gets the mission to label the unlabeled records because of the limitations of the sample records set, the effects are taken into consideration pseudo-classified information.

• in the end, categorized and pseudo-labeled information units are mixed together, which creates a incredible set of regulations that combines descriptive and predictive components of supervised and unsupervised

1.6.4 Reinforcement Machine Learning Algorithms

Reinforcement getting to know represents what is usually understood as system learning synthetic intelligence. inside the predominant system, reinforcement studying is all about developing a self-sustained system that, within the route of non-stop manner the sequences of attempts and fails it improves itself based totally on the aggregate categorized information and interactions with the incoming sample information strengthened ML makes use of the approach called exploration/exploitation. The mechanics are quite easy. reinforced ML uses the method referred to as exploration/exploitation. The mechanics are very simple and smooth – first the action takes region, results are discovered, and the next motion displays the effects of the first motion

1.7 Challenges and Limitations of Machine learning

- Primary assignment of machine mastering is the lack of correct statistics or the range inside the dataset. A machine can't examine if there's no information available. Dataset with a loss of range offers the device a difficult time.
- A system wishes to have heterogeneity to study significant pattern it's miles. It is very uncommon that a set of rules can extract facts whilst there are not any or few variations. Its miles endorsed to have as a minimum 20 observations according to

group to help the system analyze. This constraint has a tendency to terrible evaluation and prediction.

1.8 Application of Machine learning

- Pattern recognition
- Banking sector
- VLSI Design
- Augmentation.
- Automation.
- Finance Industry.
- Government organization.
- Healthcare industry
- Marketing. etc

1.9 Motivation

There are several things you could consider to apply ML to front-end digital VLSI design as well as in DWT and HMM for pattern recognition. Coding guidelines give the algorithm a lot of modules that are coded according to the guidelines and teach it the difference with the most important guideline violations. It covers a lot of different sub domains of VLSI digital design. Most useful for ASIC designs/FPGA will have a smaller rule check than ASIC's.

CHAPTER 2
REVIEW OF LITERATURE

2.1 Review

The purpose of this synopsis is to review the progress in the field of ML and pattern matching for VLSI system. ML is the process of learning new task and applying based on intelligence. Pattern matching technique deals with recognition algorithm, once trained on a particular dataset. The development of VLSI started way back in 1980, with fault-tolerant computing was at its edge, it is the art and science of building computing systems that continue to operate in a very good condition in the presence of faults. Fault tolerance and its dependable systems works on a wide spectrum of application from embedded system, design system, coding system, operating system and real-time processing [15]. Fault-tolerance technique finally became more important in deep sub-micron VLSI devices to invade increasing noise problems, high end complexity, and improving yield by tolerating defects especially for very large and complex chips [16]. Many high speed integrated operations in VLSI need complex integration of hardware implementation. In this hardware implementation numerous elements and complex interconnections usually started taking large area occupation and high power consumptions. This resulted in a saturation of VLSI architecture and system advancement. To overcome design complexity, high power input and large area occupation, researchers came with intelligence logic systems, and thus giving rise to ML application in VLSI. The whole semiconductor industry was scaling its design smaller making it more challenged in terms of manufacturing and design [17]. Studied have shown that in near future there will be saturation in Moore's law, and this brings us to the saturation in VLSI system [3]. The only way to avoid this failure is to develop the new fabrication process and update the architectural level in VLSI chips. With 3D-VLSI, Moore's law continues to hold good if challenges of increasing speed and decreasing of power is taken care of. Three-Dimensional field programmable gate arrays (3D-FPGA) are one of the most interconnected versatile devices and can benefit the outcome of VLSI architecture by 3D integration [5]. This controlling of architecture with low power input is been controlled by AI driven system, which not only helps in designing of integrated chips, but also helps in manufacturing process, decreases the dependability of large area, and full-fledged draws low power with high speed performance.

The wavelet transform (WT) is a time-frequency transform, useful for analysis of non-stationary signals with the potential of multi-resolution. The wavelets used basis functions, are localized both in time as wells as frequency. Unlike the fixed window size used by Short Time Fourier Transform (STFT), the wavelet transform uses an adaptive window size. This means that relatively more time is allocated to the lower frequencies and less time is allocated to the higher frequencies. The proposed system is based on limited training data and the performance can be improved further by increasing the amount of training data. It is of key importance to mention that the results and figures presented in this work are for speech data recorded under controlled environment. Thus, a more comprehensive future task is to enhance the system and perform the training and testing for more practical speech data under noisy environments.

Cardiac disorders are critical and must be diagnosed in the early stage using routine auscultation examination with high precision. Cardiac auscultation is a technique to analyze and listen to heart sound using electronic stethoscope, an electronic stethoscope is a device which provides the digital recording of the heart sound called phonocardiogram (PCG). This PCG signal carries useful information about the functionality and status of the heart and hence several signal processing and machine learning technique can be applied to study and diagnose heart disorders. Based on PCG signal, the heart sound signal can be classified to two main categories, normal and abnormal categories. Database of 5 categories is created of heart sound signal (PCG signals) from various sources which contains one normal and 4 are abnormal categories. This study proposes an improved, automatic classification algorithm for cardiac disorder by heart sound signal [32].

2.1 Rationale

Research Issues in VLSI Architecture using Machine Learning can be categorize as follows-

- Different VLSI Architecture using Different ML Algorithms achieves
    - 0.816K gate counts, consumes 0.873 mW of power at a working frequency of 1.1 GHz with Taiwan Semiconductor Manufacture Company (TSMC) 90-nm CMOS technology, and achieves an average bandwidth reduction of 56.08%
    - 45% and 62% average reductions in area, 21% reduction in energy consumption compared to the binary radix implementation for 65nm CMOS Technology.
- This synopsis proposes an efficient design of VLSI architecture using different machine learning algorithm to achieve lower system complexity with optimized tradeoffs.
- Designing Machine Learning algorithms which are used for efficient designing of VLSI Architecture and DWT-HMM for Pattern Recognition.

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In the late-CMOS time, semiconductor and hardware organizations face serious problems for tradeoff optimization. Area, speed and power are Tradeoff in VLSI Industry. There is need to design Efficient VLSI Architecture for Tradeoff optimization. In this unique situation, Machine Learning algorithms are used for efficient designing of VLSI Architectures and pattern recognition.

CHAPTER 3
OBJECTIVE OF THE STUDY

3.1 OBJECTIVE

1. To design efficient VLSI architecture using various Machine Learning algorithms which optimizes Area, speed and power estimations.
1. To design multidimensional DWT VLSI architecture for recognizing various patterns such as image, voice and handwriting.
2. To develop HMM-DWT Model for designing of Efficient Machine learning algorithms design with lower computational complexity.
3. To Design an optimum HMM models for noise reduction in biomedical Image processing.

CHAPTER 4
PROPOSED METHODOLOGY

4.1 Flowchart

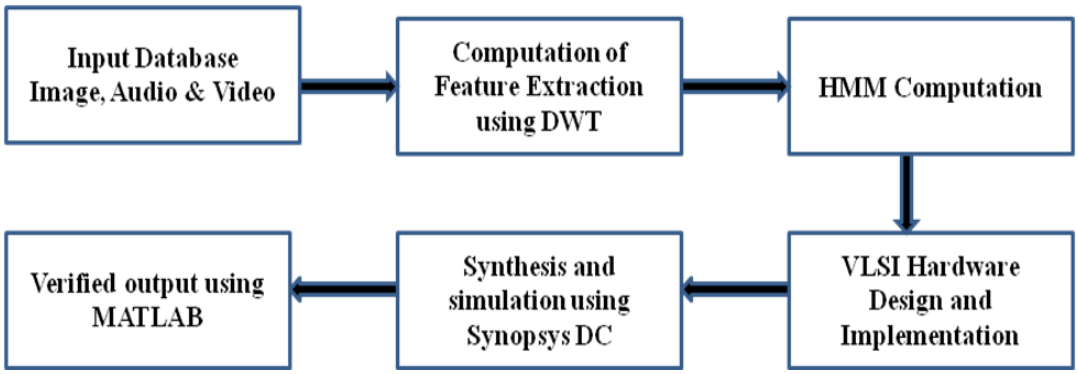

Fig 4.1 Block Diagram of Proposed VLSI design flow for HMM

The above Fig 4.1 shows Block Diagram of Proposed VLSI design flow for HMM. Each step involving research and concepts of Designing VLSI Architectures for Machine Learning Algorithms

Step 1: Input Database in Audio/Video/ Image Format. Input to the system can be given in Audio/Video/Image format.

Step 2: Computation of Feature Extraction using DWT Model. Decomposing the signal Using DWT into N levels using filtering and decimation to obtain the approximation and detailed coefficients and Extracting the features from the DWT Coefficient.

Step 3: HMM Model computation for better image recognition. HMM computation in its discrete form, process can be visualized the problem

Step 4: VLSI Architecture design and implementation, this block presenting effective VLSI architecture for ML algorithms is design.

Step 5: Synthesis of VLSI design architecture using any VLSI Tool eg: Synopsys Design Compiler.

Step 6: Output is verified with the help MATLAB tool.

4.2 RESEARCH TOOLS:

The proposed synopsis requires various software tools for the simulation purpose. Based on problems and formulation few tools have been identified with the use of which the work can be progressed smoothly. Following tools will be used for designing an Efficient Lower Computational Complexity VLSI Architecture Using Machine Learning Algorithms

Synopsys (DC), Xilinx and MATLAB.

- Synopsys gives the area-power –delay analysis.

- Xilinx for Verilog hardware description language coding and
- MATLAB for mathematical results verifying.